United States
Department of
Agriculture

Forest Service

International
Institute of
Tropical Forestry

General Technical
Report IITF–24

Big-Leaf Mahogany in Panama: Historical Perspective

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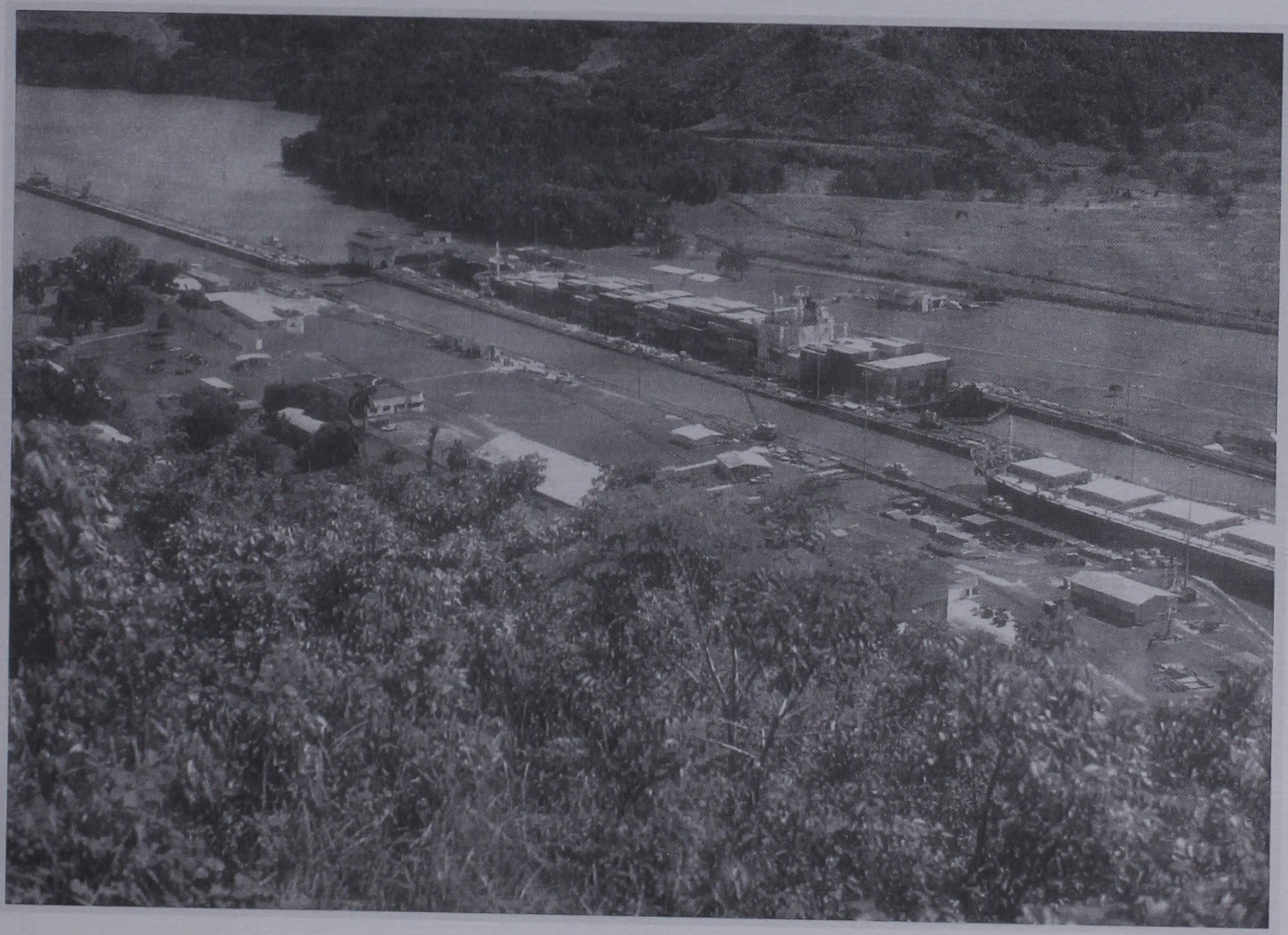

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Cover photo: Pedro Miguel locks in the Panama Canal. The canal, first traversed by the steamship "Ancon" on August 15, 1914, was conceived by the Spanish 400 years earlier.

July 2003

USDA Forest Service
International Institute of Tropical Forestry
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Abstract

The Isthmus of Panama, first used by Indians as a route between North and South America, was soon recognized by Europeans as an important crossroads linking two oceans and two continents. With Panama's colonization and settlement, the availability of big-leaf mahogany declined in readily accessible areas as early as 1670. The species remained common, however, in the interior through the beginning of the 20th century. Panama's low population density, concentrated along the canal and south of the topographic divide from Panama City west to the Costa Rican border, was a major factor that helped protect much of its forest land. No sawmills existed before work began on the canal; however, by 1913, 13 mills, mainly using big-leaf mahogany, had been established. Forests covered 86 percent of the country in 1900, declining to 70 percent in 1947, 58 percent in 1960, 53 percent in 1970, 47 percent in 1980, 40 percent in 1990, and 37 percent in 1998. In the early 1950s, the volume of big-leaf mahogany was estimated at 60 million board feet in the Darién and 75 million in the entire country. During the early 1990s, the forest industry supported 50 sawmills, 3 plywood factories, and 600 furniture shops. In 1992, as forest resources continued to decline, Panama prohibited the export of big-leaf mahogany, Spanish cedar, and select hardwoods as roundwood or sawnwood. Also during the 1990s, Panama passed laws providing incentives for reforestation, establishing forestry legislation, and creating ANAM, the national environmental authority. Today most of Panama's remaining undisturbed forests are concentrated along the Caribbean Coast and east of the canal. Big-leaf mahogany, once common, is now largely confined to scattered trees west of the canal, and to natural stands in the provinces of Panama and Darién east of the canal. The eastern forests are being harvested today by concessionaires with approved management plans.

Keywords: Big-leaf mahogany, conservation, history, Panama.

Introduction

Panama's name, confused in etymology, means either the abundance of fish, or of butterflies, or the name of a tree (Hedrick and Hedrick 1970). It was also the Indian name for the Pacific Coast village discovered by the Spaniards when they first traversed the isthmus in about 1515 (Perez-Venero 1978). Despite its relatively small size, the country's location and topography provide a diversity of habitats and wildlife, making any of the above the possible origin of its name.

Panama was first used by Indians as a bridge between continental areas. Soon after discovery by the Europeans, it was recognized as an important crossroads between two oceans and two continents. Panama was the first European settlement that offered convenient access to the western coasts of Central and South America. Indeed, recognizing its strategic importance, Simón Bolivar suggested the country as a potential World capital should one ever be created (Pan American Union 1955).

Panama belongs geologically to Central America, historically to South America, and geopolitically to the Caribbean (Whittlesey 1939). Panama's role in the Caribbean began early when it was part of the Spanish Main extending from Portobelo along the South American coast to the Gulf of Paria in Venezuela (Roberts 1940). Later, reference to the Spanish Main was broadened to include the lands and waters of Central America and the Caribbean, areas visited and traversed by Spanish galleons after gold was found in the New World. During the 19th and 20th centuries, Panama's tie to the Caribbean was through commerce and travel between the east and west coasts of the United States, by means of either the Panama railroad or the canal.

Panama is also the narrow bridge that connects northern and southern populations of big-leaf mahogany (*Swietenia macrophylla* King) and Spanish cedar (*Cedrela odorata* L.), species of concern to both timber-producing countries and conservation groups. Beginning with Panama's period of colonization and settlement, and continuing through the 20th century, big-leaf mahogany was the species favored for construction and woodworking. The purpose of this review, derived from published and unpublished sources, is to outline the history of big-leaf mahogany in Panama. Information on Spanish cedar, when encountered, is also included. This document relies heavily on local literature and parallels two previous reports on Belize (Weaver and Sabido 1997) and Nicaragua (Weaver and Bauer 2000).

Panama—The Setting

Panama, occupying 77 080 km² of the Central American isthmus, is 770 km long and from 50 to 190 km wide (fig. 1). The Canal Zone (called the Canal Area after 1977), occupies 1432 km² and divides the country into two nearly equal parts. The narrow isthmus and close juxtaposition of

Figure 1—Panama: names of provinces and site names mentioned in text but not given in remaining figures.

mountain ranges, coastal plains, rivers, and seacoasts, present a diversity of natural habitats (Helms 1979). Panama has 218 mammals, 929 birds, 226 reptiles, and 164 amphibians—more than any other Central American republic (Harcourt and Sayer 1996, Ridgely and Gwynne 1989, World Conservation Monitoring Centre 1992). More than 1,000 species of plants and animals are endemic (Navarro and Fletcher 1988).

Geology and Physiography

The geologic history of Panama begins in pre-Tertiary time, possibly early Cretaceous; the earliest rocks are calcareous marine sediments lying on older volcanic deposits (Stewart 1975). By the late Pliocene, the entire isthmus had been raised above sea level by tectonic activity, a condition that has continued to the present. During the Pleistocene, glaciers lowered sea level by more than 100 m, facilitating animal migrations. Most of the country today is in the mature stage of erosion as evidenced by numerous hills and valleys.

Panama's mountains are oriented east-west with a gap at the canal (Holdridge and Budowski 1956). In western Panama, the Continental Divide lies near the center of the country (Porter 1973). Near the canal, much lower in elevation, the divide lies closer to the Pacific, and in the eastern half of the country it is closer to the Caribbean. Panama's critical location has served as an avenue for plant and animal dispersal since the middle of the Pleistocene (Bennett 1968).

The country is characterized by four regions (Harcourt and Sayer 1996)—western, dominated by the Talamanca Cordillera extending southwest from Costa Rica; central lowlands, containing the canal; eastern, with a series of coastal ranges; and the narrow lowlands of the Caribbean Coast (fig. 1). Elevations range to 3427 m at Barú Volcano in the west. The highest point in eastern Panama is Cerro Tacarcuna which reaches 1860 m near the Colombian border (Porter 1973). Most of the isthmus, however, lies below 500 m, with nearly 90 percent below 1000 m. The Darién Province in the east has the largest rivers.

Climate

Panama's climate is characterized by a wet season from May to November, and a dry season from December through April (Boyer and others 1980). The wet season, governed by the position of the intertropical convergence zone, has uniform temperatures, high humidity, gentle breezes, and heavy, frequent, convectional downpours. During a normal year, Panama receives an average of 3000 mm of rainfall over the entire country.

Panama's topography also plays an important role in the distribution of rainfall. The mountainous interior, running east to west, causes orographic precipitation along the Caribbean Coast, with most rainfall occurring at elevations around 1500 m (Holdridge and Budowski 1956). Several areas receive >4000 mm per year (fig. 2). As a result, the Atlantic slopes north of the Continental Divide are humid and rainfall is relatively homogeneous during the year; in contrast, the Pacific region south of the divide has a pronounced seasonality, with a dry season from December to April (FAO and PNUMA 1981; see app. A for acronyms used in text and literature citations). Winds crossing the country accentuate dryness on the Pacific side (Holdridge and Budowski 1956).

All of Panama's lowlands have a mean annual temperature greater than 24 °C (Holdridge and Budowski 1956). The Pacific region has both moist and dry areas, but is mainly dry. The eastern part of Azuero Peninsula, with rainfalls as low as 1100 mm per year (Boyer and others 1980), is the driest area in the country. Because Panama is south of the Caribbean hurricane belt, it escapes the storms that affect Central American countries from Costa Rica to Belize.

Flora and Forests

Panama has 12 ecological life zones, 4 of which occupy 80 percent of the country (Boyer and others 1980, Tosi 1971). The life zones and their proportional areas, in percentages, are as follows: tropical dry forest (7.5), tropical premontane dry (2.7), tropical moist (32.4), tropical premontane moist (3.2), tropical wet (14.4), tropical premontane wet (20.1), tropical premontane rain (13.2), tropical lower montane moist (0.01), tropical lower montane wet (1.8), tropical lower montane rain (3.1), tropical montane wet (0.005), and tropical rain forest (1.6).

In general terms, lowland rainforests cover the Caribbean slopes and seasonal, deciduous forests occupy the Pacific side of the Continental Divide (Harcourt and Sayer 1996). Mountainous forests, generally lower in height, cover the uplands, particularly along the Costa Rican border. Swamp forests grow in the lowlands of the Darién, and mangroves grow along both coasts but are more extensive along the Pacific shore because of the higher tides.

The major forest types of Panama group into seven broad categories (Boyer and others 1980, Harcourt and Sayer 1996) (table 1). The orey (*Camonosperma panamensis*)

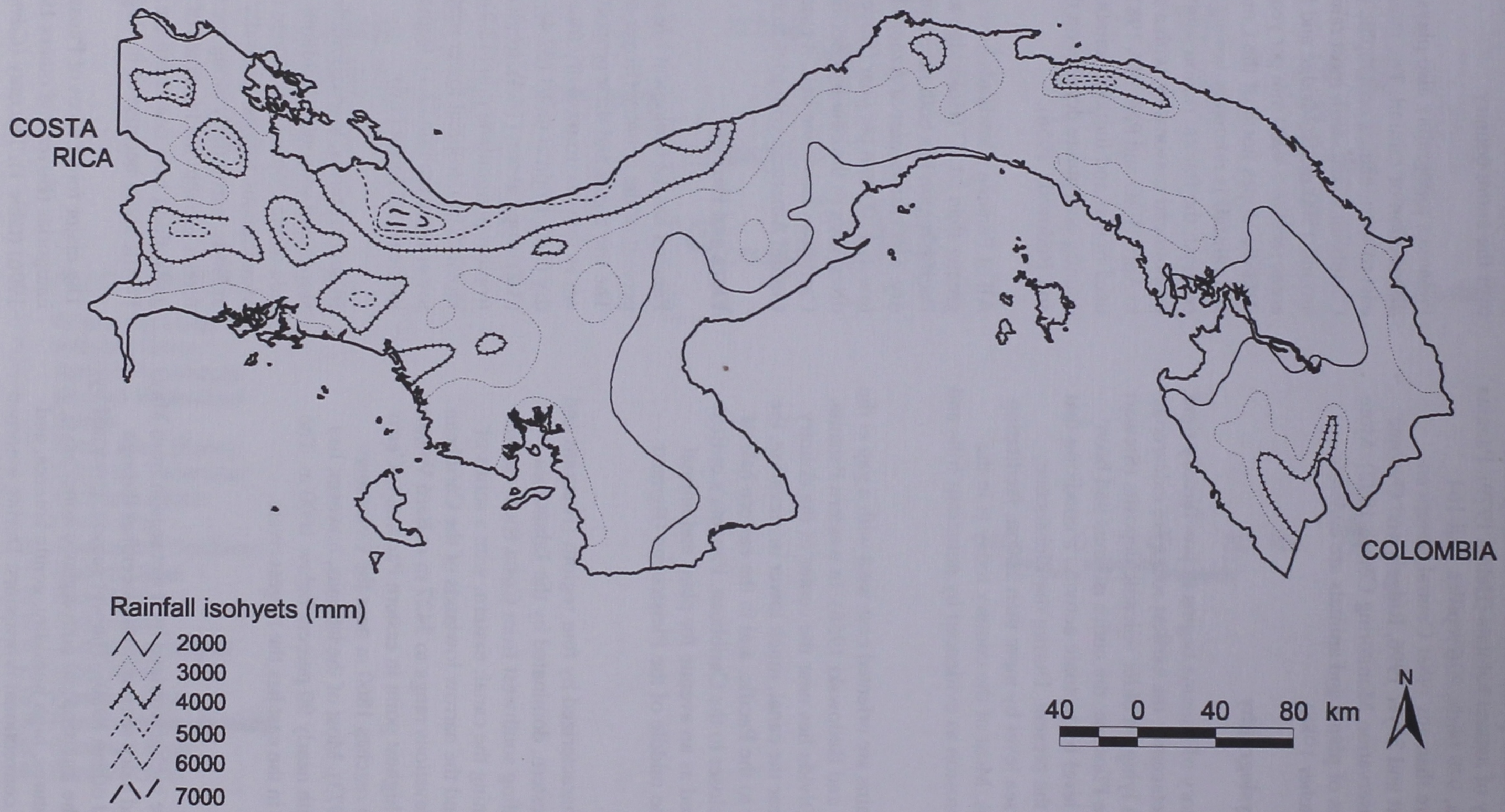

Figure 2—Rainfall isohyets in Panama (República de Panamá, Ministerio de Obras Públicas, no date).

Table 1—Major forest types in Panama as of 1980

Forest type	Land area	
	km^2	%
Orey[a]	450	1.3
Orey + other species	170	0.5
Cativo[b]	300	0.8
Cativo + other species	195	0.5
Mixed forests[c]	17 880	50.4
Mangroves[d]	1 760	5.0
Protection forests[c]	14 740	41.5
Total	35 497	100.0

[a] *Camonosperma panamensis*.
[b] *Priora copaifera*.
[c] Contains big-leaf mahogany.
[d] Dominated by *Rhizophora brevistyla* and *R. mangle*.
Source: Harcourt and Sayer (1996), INRENARE (1990).

forest grows in brackish water swamps around the Chiriqui Lagoon in northwestern Panama. The stands are pure and dense, containing among the highest volumes known for tropical forests. In areas of better drainage, areas of orey are mixed with other species. Cativo (*Priora copaifera*) forests occur in pure or nearly pure stands in well-drained alluvial terraces along major rivers, for example, those that drain into the Gulf of San Miguel in the Darién. Cativo mixes with other species in slightly better drained sites. The mixed forests, mainly in eastern Panama, include those that contain cuipo (*Cavanillesia platanifolia*)—about 10 000 km^2 or slightly more than one-half of the total (Boyer and others 1980)—and those that are characterized by other canopy species. Mangroves are dominated by four tree species. Protection forests, an administrative classification, include various forest types in different areas.

The number of higher plants recorded during the 1960s was 5,134 (D'Arcy 1987). In the early 1970s it was suggested that Panama's entire flora could double if inaccessible areas such as the Atlantic slope, higher elevations near the Costa Rican border, and the Darién, were properly sampled (Dressler 1972). By the mid-1980s, additional sampling had increased the number to more than 8,100 in 195 families, including the Pteridophytes (D'Arcy 1987). The five most common families—Orchidaceae, Leguminosae, Rubiaceae, Graminae, and Compositae—contain more than one-quarter of the species. In the early 1990s certain areas still remained poorly sampled; investigators estimated that Panama had nearly 9,400 species of angiosperms, gymnosperms, ferns, and fern-allies (Correa and Valdespino 1998, Hampshire 1989).

Meliaceae

Panamanian forests contain numerous species in the mahogany family, or the Meliaceae (D'Arcy 1987, Woodson and others 1965). The major genera are *Carapa*, *Cedrela*, *Guarea*, *Melia*, *Swietenia*, and *Trichillia*.

Big-leaf mahogany has been recorded in the following life zones: tropical moist forest, tropical dry, and tropical premontane moist forests (Tosi 1971); and tropical wet and tropical premontane wet forests (Lao 1999). These life zones comprise nearly two-thirds of Panama's total surface area. Among the more common species growing in association with big-leaf mahogany in Panama are: *Guaicum sanctum*, *Ceiba pentandra*, *Cordia alliodora*, *Bombacopsis quinata*, *Cedrela odorata*, *Ochroma lagopus*, *Chlorophora tinctoria*, *Cecropia obtusifolia*, and *Spondias mombin* (Navarro 1999). The species grows naturally along the Pacific side of Panama (Lamb 1966) (fig. 3) in humid areas below 900 m in elevation (Allen 1964, Garibaldi Escobar 1982a). Moreover, it grows along with Spanish cedar in the mixed forests (table 1) situated on the well-drained lower slopes of the Panamanian orient in an association referred to as "old secondary forest." The commercially important mixed forests of the Darién contain cuipo, cedro espino (*Bombacopsis quinata*), and ceiba (*Ceiba pentandra*) as the dominant species (Falla-Ramírez 1978a, Mayo Melendez 1965). In this forest, big-leaf mahogany and Spanish cedar rarely occur as canopy dominants (Golley and others 1975).

Big-leaf mahogany trees may reach 30 to 45 m in height and 2 m or more in diameter above the buttresses. In the Darién, an average concentration of a commercial size big-leaf mahogany is less than four-tenths of a tree per hectare. Stem density, however, varies considerably by site. In some areas there are no big-leaf mahogany and in others, there are isolated occurrences of 35 to 50 trees per hectare (Lamb 1953). During early botanical surveys, the species was also seen growing sparingly in the upper Chagres River and Bayano watersheds (fig. 1) (Standley 1928).

Big-leaf mahogany does not grow along the Caribbean Coast of southern Costa Rica, or of Panama, probably because the area has a very wet climate with a dry season <1 month in duration (Calvo and others 2000). Incidentally, this same coast is free of the hurricanes that help create forest openings. Such openings facilitate the regeneration of big-leaf mahogany in other parts of Central America.

During the many years of its exploitation, big-leaf mahogany was esteemed for use in passenger coach work,

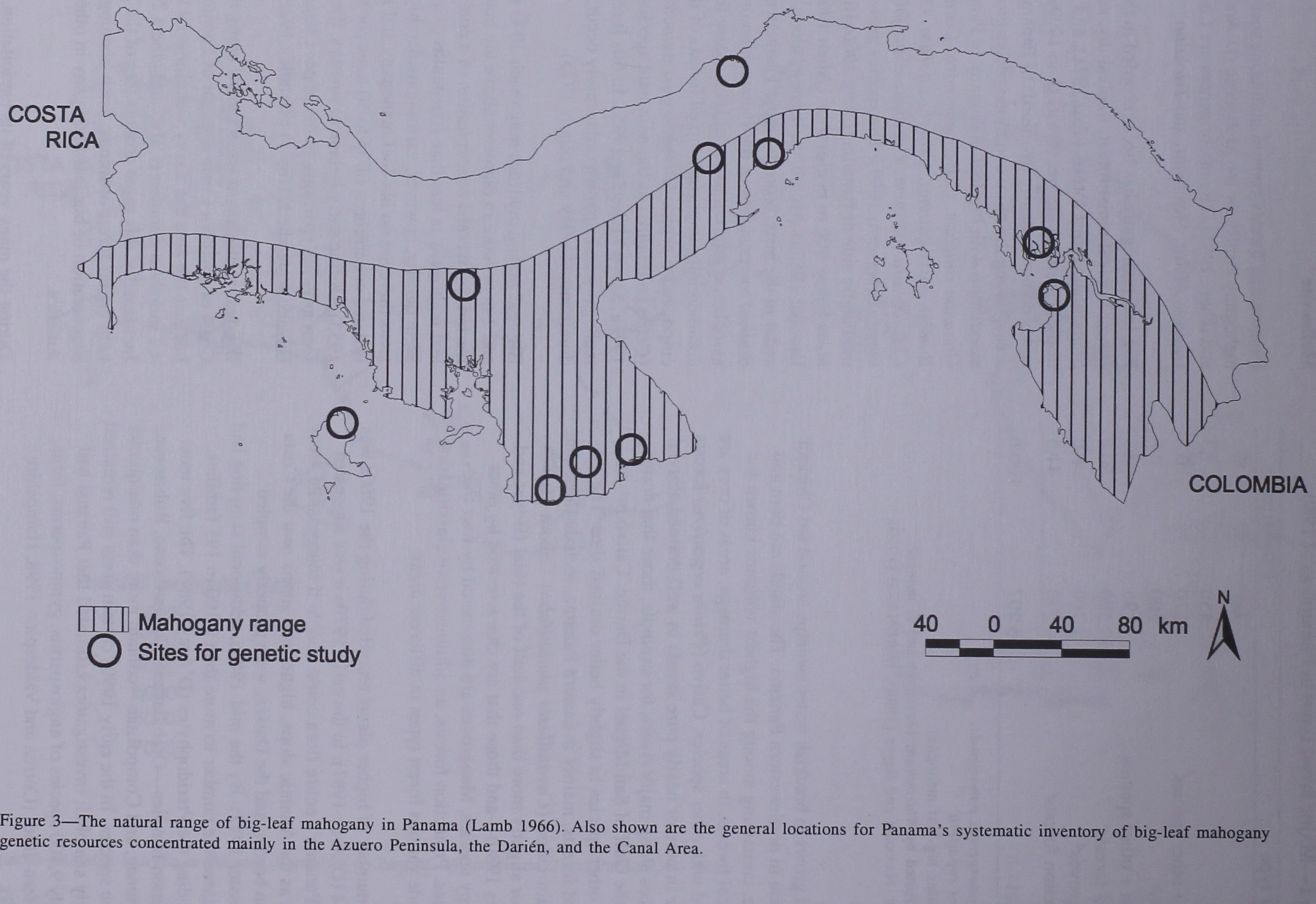

Figure 3—The natural range of big-leaf mahogany in Panama (Lamb 1966). Also shown are the general locations for Panama's systematic inventory of big-leaf mahogany genetic resources concentrated mainly in the Azuero Peninsula, the Darién, and the Canal Area.

office furniture, interior trim, cabinets, floors, carpentry, marine construction, plywood, and general construction, and was occasionally used for railroad ties and pulp (Braddy 1930, Garibaldi Escobar 1982a). Observant lumbermen, however, noted that there were differences in wood characteristics according to site. Trees growing at low elevations along the Pacific Coast had a coarser texture and greater porosity than those growing at higher elevations. Upland trees were heavier, harder, and easier to polish.

Spanish cedar frequently reaches 40 m tall with diameters 0.6 to 1.2 m d.b.h., and sometimes to 2 m. Clean trunks often extend 15 to 25 m above ground level. The species has many of the same uses as big-leaf mahogany including fine woodworking, furniture, cabinets, cedar chests, internal construction, and floors (Braddy 1922, Lamb 1968). It was also used for boats, canoes, and musical instruments. With a greater range than big-leaf mahogany in Panama, Spanish cedar also demonstrates variable wood properties according to site. At high elevations with good drainage, or on dry sites, the wood is denser, has a more pronounced reddish color, and the aroma is more intense.

History of Big-Leaf Mahogany in Panama

Human Occupation

Panama's rainfall patterns indicate that it was virtually all forested before the arrival of humans. Carbon dating elsewhere in the Western Hemisphere suggests that human groups must have been present on the Isthmus of Panama at least 10,000 years ago (Bennett 1968, Loftin 1972). Panama was passed through, and lived in, hundreds of years before crops were grown. The precise date when agriculture appeared in Panama is not known, but estimates range from 250 to as many as 5,000 years B.C. At the time of the Europeans' arrival, Panama's fertile land, numerous watersheds, and abundant wildlife provided the subsistence resources for at least 60 Indian chiefdoms (Helms 1979) (appendix B). Three groups related to the Chibchas were prevalent then and are still found today in Panama—the Cuna, the Chocó, and the Guaymí.

Rodrigo de Bastidas, the first European in Panama, arrived in 1501. The following year, on his fourth voyage, Columbus explored the country's Caribbean Coast (OAS 1971). The earliest Spanish settlements included Nombre de Dios, first established by Columbus in 1502. In 1513, on an exploratory quest for gold and the "South Sea" (Pacific Ocean), Governor Vasco Núñez de Balboa sighted the Pacific from a peak in the Darién (Sauer 1966). His venture proved that the isthmus could be traversed by a large group in only a few days. Moreover, he showed that the natives were obedient and devoted to their chiefs, since they would strip themselves of gold and other valuables to ransom them. In 1519, Pedro Arias Dávila, Balboa's successor, founded Panama City on the Pacific Coast. With the Caribbean and the Pacific now connected by road and river, Panama became the crossroads of the Americas.

In 1523, Charles V of Spain ordered Cortes to search for a strait across the isthmus (Arosemena 1961, Haring 1918). In 1534, he directed the governor of Panama to take expert personnel and examine the territory between the highest navigable point on the Chagres River and the Pacific Ocean and determine the best means of cutting a canal from the river to the ocean. Thus, in less than one-third of a century after discovery, the idea of a transisthmus canal had been conceived. By 1539, the Spanish had explored nearly all of Panama, whose jurisdiction extended from the Río Atrato in northwestern Colombia to beyond Bocas del Toro and Burica in the west (Villegas 1917).

From 1533 to 1750, Panama was the center of Spain's viceroyal government stretching south to Peru (Schooley and Wearne 1997). In 1751, the center was moved to Bogotá, Colombia. The 19th century was a period of unrest for Panama. In 1821, Panama declared its independence from Spain along with the rest of Central America and joined the Republic of Greater Colombia (Colombia and Venezuela), already independent from Spain since 1819. Panama briefly seceded from Colombia in 1830, and again for 13 months in the early 1840s. From 1850 to 1902, at least 53 revolutions, rebellions, insurrections, riots, and other outbreaks in Panama showed that the Colombian Government, centered in Bogotá, was incapable of controlling the isthmus (Speller 1972). Finally, in 1903, Panama achieved independence from Colombia.

The idea of building a canal across the isthmus, conceived originally by the Spanish in colonial times, was not initiated until the 1880s (Arosemena 1961, Haring 1918, Villegas 1917). Meanwhile, the isthmus was first crossed via an Indian trail, and then by a Spanish cobble road soon after discovery of the Pacific Ocean. By 1855, the transisthmus railroad was completed, and finally, by 1914, the Panama Canal. Even before its independence from Spain, Panamanians had developed what some intellectuals described as a "transit" personality (Perez-Venero 1978). It is ironic, however, that Panama, the renowned crossroads of the Americas for millennia, contains the Darién Gap, the only missing stretch of the Pan-American Highway between Alaska and Chile.

Because of introduced diseases, war, and indiscriminate use of Indians as a source of labor in mines and agriculture, only a small portion of Panama's estimated 400,000 original inhabitants survived the Spanish conquest (Bennett 1968, Villegas 1917). The rapid decline of the Indians was not immediately matched by an increase in the number of Europeans and Africans, the latter being brought over in the 16th century as a substitute source of labor. Between 1850 and 1950, as many as 200,000 West Indians traveled to Panama in search of employment and a better life (Conniff 1983). There were four major influxes: 1850 to 1855, for the construction of the Panama railroad across the isthmus; 1880 to 1889, for the unsuccessful attempts by the French to excavate a canal; 1904 to 1914, for the construction of the United States' canal; and 1940 to 1942, in preparation for the construction of another lock that was never completed.

Panama's 1960 census revealed more than 62,000 indigenous people, or 5.8 percent of the total population (Medina 1972). These groups live in areas where they are the main inhabitants, operate under a tribal organization, speak a separate dialect, and maintain their traditions and customs. In 1972, 17 percent of the country was occupied or regularly used by indigenous peoples. The Cuna live on the islands of San Blas northeast of Colón City (fig. 1), and in two main areas in the Darién at the headwaters of Pacific Coast rivers. The Chocó, also in the Darién, occupy lands near the current border with Colombia. The Guamí are situated in western Panama along the Costa Rican border (Diagram Group 1985).

Population estimates are available for the entire country at different times: 150,000 at the beginning of the 16th century, 25,000 in 1607, 40,000 in 1691, 80,000 in 1778, and 92,000 in 1832 (Bennett 1968, Jaén Suárez 1981). A census in 1851 yielded 129,000 persons; one in 1864, 222,000; and one in 1880, about 308,000. By 1911, about 337,000 people occupied the country, increasing to 850,000 in 1952 (Holdridge and Budowski 1956), and to 2,500,000 in 1994 (Harcourt and Sayer 1996). In 1994, the average population density was 33 persons per square kilometer. Today, one-third of the country's population lives within 16 km of the canal, and one-half within Panama City and Colón.

Nearly 60 years ago, Panama's foresters first called attention to forest destruction and the need for management (Moral 1944). About 40 years ago, a call was made for the rational use of forest resources (Cornejo 1963). Heeding these early concerns would have benefited forest industry considerably. Somewhat later, the effects of accelerated forest destruction accompanying colonization were shown to cause serious social and environmental problems (Heckadon Moreno and McKay 1984). The slash and burn techniques used to convert dry forest to grazing lands in the Azuero Peninsula—the annual burning and overgrazing—combined with prolonged droughts, changed parts of the region into a virtual desert, causing an exodus in population during the 1960s and 1970s. During the 1970s, the Darién was colonized and its rain forest burned, much of it without timber harvest. Big-leaf mahogany and Spanish cedar trees, possibly hundreds of years old and with considerable commercial value, went up in smoke!

In 1993, an internal survey was initiated to determine the causes of deforestation and alternatives to control it (Comisión Interinstitucional y Multidisciplinaria Sobre la Deforestación 1993). Numerous political, legal, and institutional causes were found, among them

- Deficient forestry legislation
- A lack of effective control at the national level
- Underevaluation of forest resources
- Opening up of access roads
- Inadequate policies relating to agrarian activities and credit

The socioeconomic and technological causes included

- Population growth
- Poverty
- Forest exploitation
- Nonsustainable agriculture
- Widespread livestock grazing
- Limited technology with insufficient technology transfer

Several actions were proposed to minimize the inadequate use of renewable natural resources. These, of course, would count on a strong commitment from the Panamanian Government to be successful. Among the proposed actions were

- Appropriate land use
- National forestry and agroforestry projects
- Conservation and management of protected areas
- Institution building in the area of natural resources

Exploitation and Inventories

At the time of discovery, Panama's forests had been only slightly disturbed by the Indians, mainly in areas along rivers where they practiced subsistence agriculture

(Helms 1979), and where they occasionally cut big-leaf mahogany for making their cayucas, or boats (Haskin 1914). By 1670, however, much of the readily available big-leaf mahogany in the vicinity of settlements had been cut and used in the construction and decoration of mansions (Robinson and Graham, no date). Henry Morgan's sacking and burning of Panama City in 1671 resulted in the loss of "native cedar and odorous rosewood" (Lindsay 1951), a description that may have included big-leaf mahogany as well. During the late 19th century, it was not uncommon to see bridges 13 m long and 1.5 m thick constructed of big-leaf mahogany logs (Haskin 1914). Also at that time, buildings in the major towns were made of wood, but fires, as early as 1914 in Panama City, led to a policy limiting wooden structures (Cummings 1955).

At the beginning of the 20th century, logging was uncommon and 86 percent of the country remained forested (Zon and Sparhawk 1923). The Caribbean Coast was all forest with the exception of a few clearings for settlements and plantations. Most of the land east of Panama City toward the Colombian border, including the Darién which was largely in public ownership, was also forested. Fine timbers, including big-leaf mahogany and Spanish cedar, were still plentiful where distant from settlements (Villegas 1917). Early surveys in the Bayano River watershed in eastern Panama showed that Spanish cedar was uncommon, but occurred on a variety of sites (Kluge 1926). Spanish cedar was also reported around 1910 in Panama's western forests, notably south of Barú Volcano, at elevations above 1000 m (Pittier 1918). Timber supplies dwindled, however, soon after the arrival of settlers. About a decade later, Spanish cedar was exhausted on the northern slopes, having been logged for construction and furniture (Cooper 1928).

No sawmills existed in Panama before work began on the canal in the first decade of the 20th century (Cummings 1955). During the canal's construction, however, big-leaf mahogany and Spanish cedar were cut locally and used for cabinets, panels, doors, the interior finish in the canal's railroad coaches, and furniture on ships (Braddy 1920a, 1920b). By 1913, Panama had six sawmills used mainly to cut big-leaf mahogany. The number of sawmills increased during World War I in an effort to develop local timber resources (Cummings 1955, Zon and Sparhawk 1923). As part of the war effort, the U.S. Government operated a sawmill on the shores of Gatún Lake in the Canal Zone (Babbitt 1919; Braddy 1920a, 1920b, 1922). Big-leaf mahogany was likewise treasured by the U.S. military for the construction of aircraft and boats (Anónimo 1944).

In 1947, 70 percent of the country was still in forest cover but dramatic changes were underway (Garver 1947a, 1947b). At that time, cutting big-leaf mahogany for export to the United States was a longstanding business (Cummings 1956). Subsequent estimates of forest cover in later years were as follows: 68 percent of the country in 1950, 58 percent in 1960, 53 percent in 1970, 50 percent in 1974, 47 percent in 1980, 40 percent in 1990, and 37.5 percent in 1998 (Boyer and others 1980, Cobos Moran 1992, Falla-Ramírez 1978a, FAO 1998, Harcourt and Sayer 1996, INRENARE and SIG 1995) (fig. 4). For the year 2000, forest cover was projected at 33 percent of the country. Annual deforestation averaged 1.6 percent, or 65,000 ha per year, between 1970 and 1989 (Cobos Moran 1992, FAO 1993), and 2.1 percent, or 64 000 ha per year, between 1990 and 1995 (FAO 1998).

Before 1947, there were no inventories of Panamanian forests, although 22 sawmills were in operation; at that time, the forests covering about 70 percent of Panama's land area, or 5.2 million ha, were thought to have some commercial potential (Garver 1947a, 1947b). A need was seen for both forest inventories and forest management. In the early 1950s, Lamb (1953) reduced Garver's estimates of forest land with commercial potential to 3.5 million ha. At that time, the forests in the Darién covered 1.52 million ha but no detailed surveys of forest standing timber existed (Lamb 1953, 1954). Big-leaf mahogany had been removed from accessible areas by logging or agriculture, and where found, its average stocking was about one tree per hectare. Lamb (1953) estimated that 60 million board feet of big-leaf mahogany timber remained in the Darién and 75 million board feet remained in the entire country.

Timber extraction near the Sabanas River in the Darién (fig. 1) was characterized by the skidding of logs 2 km to trucks, which then hauled them from 8 to 25 km to log dumps along a streambank. A large proportion of the big-leaf mahogany was described as overmature and defective, having been damaged by termites and heart rot. Lamb urged that cutting should not be restricted because the timber would deteriorate. The establishment of plantations in secondary forests with partial shade was recommended to assure a future crop of trees. Suggestions for postharvest reforestation included the use of stock 1 m tall, leaf pruning, and planting during the early part of the rainy season. A planting density of 250 trees per hectare was recommended with expectations for 125 crop trees at maturity. An inventory of Panamanian forests was also recommended. These recommendations were not followed at the time.

In 1955, Panama had 75 sawmills, ranging in capacity from a few hundred to 20,000 board feet per day, and one

Figure 4—Forest cover in Panama, 1992 (INRENARE y SIG 1995). The major forest industrial zones as of 1970 are also indicated as follows: 1 = Chiriqui Highlands; 2 = Bocas del Toro; 3 = La Capitana and Bayano River, 4 = La Palma and Tuira River, 5 = Azuero Peninsula and Coiba Island; and 6 = the Donoso District (Booth and Haugaard 1972).

plywood factory (Cummings 1955). Big-leaf mahogany and Spanish cedar were favored by the furniture industry. At that time, the quantity of wood used for construction was impossible to ascertain. By 1960, Panama's furniture industry had 66 plants employing 1,000 persons.[1] The largest plant had 150 workers and the next largest had 60; very few plants had more than 10 individuals. Furniture for the domestic market was custom-made, and big-leaf mahogany was the favored wood. Most timber was air-dried, sawmill wastes were excessive, and numerous complaints were received about poor-quality products. High importation costs assured that the local plywood plant had a monopoly on domestic sales.

A few forest inventories conducted from the mid-1950s to the mid-1980s recorded either big-leaf mahogany, Spanish cedar, or both (table 2). At Fort Clayton (fig. 1), the density of big-leaf mahogany trees was high, although the areas surveyed were small and the enumeration included saplings. Another notable area was a 5000-ha patch of undisturbed forest located along the provincial divide between Santos and Veraguas in the Azuero Peninsula that had several very large, well-spaced, big-leaf mahogany trees (table 2) (Castañeda and others, no date). The sampling area, comprising only 36 ha, had an average per-hectare density and volume of 0.83 commercial trees and 14.8 m^3, respectively. On a national scale, however, where different life zones, forest types, and density classes were sampled and grouped in data analysis, estimates for densities and volumes of big-leaf mahogany and Spanish cedar averaged much lower (table 2) (Calvo and others 2000, PNUD and FAO 1972).

In the 1960s, the exploitation of big-leaf mahogany and Spanish cedar in eastern Panama was carried out by the selective removal of scattered individuals using tractors (Donaldson and others 1963). Earlier operations employed horses or oxen. Logs were dragged for more than 15 km in favorable topography. In more rugged terrain, logs were sawn into lumber that was hauled by oxen to the nearest assembly point or river. Under this method, the forest remained relatively undisturbed but the prime species were eliminated from all but the least accessible areas. Law required the planting of three individuals for each tree cut, but even where implemented, the seedlings were soon overgrown with weeds and vines.

Between 1968 and 1976, Panamanian logging concessions were granted for 2-year periods. They totaled 27 000 ha and were located mainly in the Darién (FAO and PNUMA 1981). The amount of timber exploited averaged about 10 m^3 per hectare. The use of old equipment and the physical conditions of the region made the extraction costs high. At that time, big-leaf mahogany and Spanish cedar made up 11 percent of the volume and 14 percent of the value of the extracted timber.

In 1970, the private sector in forestry comprised nearly 100 enterprises including timber harvesters, sawmill operators, and specialists in carpentry and furniture manufacture (Falla-Ramírez 1978a). The major industrial zones were (Booth and Haugaard 1972) (fig. 4)

- The Chiriqui Highlands bordering Costa Rica
- Bocas del Toro around the Chiriqui Lagoon
- The Donoso District along the Caribbean Sea
- The Azuero Peninsula and Coiba Island
- La Capitana and Bayano River watershed east of the Canal
- La Palma and Tuira River valleys in the Darién

Big-leaf mahogany and Spanish cedar remained among the most utilized species. An estimated 56 sawmills had a production capacity of 40 million board feet (Falla-Ramírez 1978b). Data regarding the status of forest industries for 1972 were as follows: 60 sawmills, 4 plywood factories, 1 particleboard factory, and 3 paper mills (Conn 1972). In 1973, the number of mills decreased to 43 but production capacity remained the same. By 1990, the forest industry included 50 sawmills, 600 furniture shops, and 3 plywood factories (FAO 1998, Harcourt and Sayer 1996, INRENARE 1990). From 1978 to 1988, total employment in the forestry sector was estimated at between 5,000 and 6,000 persons (INRENARE 1990). During the 1990s, the forestry sector contributed 1 percent of the gross national product (GNP), a figure that did not reflect 850,000 m^3 of fuelwood used by 700,000 persons and 1,660 small businesses (FAO 1998).

Through the mid-1960s, postlogging deforestation by settlers had not been a great problem in the Darién (FAO and PNUMA 1981). From 1957 to 1963, only about 2500 ha were cleared. However, by 1976, about 400 families were clearing about 3000 ha per year to plant rice and subsistence crops; estimates by 1980 placed clearing at 5000 to 6000 ha per year. Although growing, the rate of settlement was hindered by the lack of infrastructure.

Once the proposed route of the Pan-American Highway became known, settlers arrived in advance of both the construction companies and the loggers (Lamb 1966).

[1] Graham, Paul H. 1960. Panama furniture industry. Panama City, Panama: Industrial Development Center; U.S. Operations Mission. 48 p. (unpublished).

Table 2—Summary of inventory data for big-leaf mahogany (*Swietenia macrophylla* King) and Spanish cedar (*Cedrela odorata* L.) in Panama

Location and size class	Forested area	Big-leaf mahogany		Spanish cedar		Source
		Stems	Volume	Stems	Volume	
	ha	*no./ha*	*m³/ha*	*no./ha*	*m³/ha*	
Fort Clayton[a]						Robinson and Graham (no date)
≥15 *cm*	130	7.4	—	—	—	
≥15 *cm*	13.8	25-30	—	—	—	
Province[b]						Donaldson and others (1963)
Colón ≥45 *cm*	123 700	—	0.20	—	—	
Panama ≥45 *cm*	580 600	—	0.34	—	0.24	
Darién ≥45 *cm*	1 446 500	—	0.40	—	0.44	
Distrito de Donoso[c]	153 500					Enríquez Quintana (1971)
<40 *cm*		—	—	0.15	—	
≥40 *cm*		—	—	0.05	—	
Azuero[d] >50 *cm*	5 000	0.83	14.8	—	—	Castañada and others (no date)
Darién[e] >30 *cm*	17 750	—	—	0.36	0.51	Martín Núñez (1984)
Darién[f] >40 *cm*	30	—	—	0.03	0.11	Martín Núñez and others(1983)
Panama[g]						PNUD y FAO (1972)
10- 20 *cm*		0.003	—	0.009	—	
20- 40 *cm*		0.003	—	0.025	—	
40- 60 *cm*		0.003	0.004	0.022	0.029	
60- 80 *cm*		0.003	0.008	0.003	0.009	
80-100 *cm*		—	—	0.012	0.067	
100-120 *cm*		—	—	0.006	0.059	
>120 *cm*		0.006	0.102	0.003	0.057	
Total		0.018	0.114	0.114	0.221	
Panama[h] >60 *cm*	1 049 700	0.025	0.11-1.25	—	—	Calvo and others (2000)

— = Data not available.

[a] Different forest types with mahogany. Spanish cedar was reported but neither density nor volume were estimated.
[b] Scribner rule, 250 board feet = 1 m^3 in mixed upland, evergreen rain, quipo, and cativo forest types.
[c] Species listed only as "cedro"; presumed to be Spanish cedar.
[d] Study represented 5000 ha but only 36 ha sampled.
[e] Area bordered by Chico, Tupisa, and Tuquesa Rivers.
[f] Bosque Especial Canglón-Mamey.
[g] Based on a sample area of 320.75 ha taken during a national inventory of Panama's forests. Separate plot tally sheets provide detailed information.
[h] Report states "in all regions." This is about 10 500 km^2, or that portion of Panama where big-leaf mahogany may still be found.

Forests rich in big-leaf mahogany were felled and burned over an area of 250 km² in only 10 years. Loggers estimated that less than one-half of the big-leaf mahogany was actually cut for sale despite the satisfactory pricing of the wood at the time. Panama and Colombia have agreed to build the Pan-American Highway through the Darién. Completion of the road would undoubtedly lead to a major influx of settlers and the demise of most of the remaining forest resources, including big-leaf mahogany and Spanish cedar. The road's impact on native populations and wildlife, both dependent on the forest, are also major concerns (Hanbury-Tenison and Burton 1973). Possible deterrents to completion of the road are the high costs associated with construction, and a concern by the United States and Mexico regarding hoof-and-mouth disease.

Chronology of Major Meliaceae Exports

Panama records timber exports in board feet and log exports in kilograms.[2] Export data are extremely difficult to find in Panama; moreover, exports account for a variable portion of the total volumes removed annually. The amount of wood that was abandoned in the forest, cut but not reported, burned during land clearing, lost during processing, or used in local construction during the 65-year period is unknown. By 1990, only 22 percent of the total timber volume (all species) being cut was exported, with the remainder being used internally (INRENARE 1990). At that time, exports amounted to only 1 percent of the GNP.

Panama has exported big-leaf mahogany to the United States since 1908 (Calvo and others 2000), yet in comparison with other timber-producing countries, it has not been an important source of logs (Lamb 1966). In 1916 and 1917, Panama exported 110,000 and 140,000 cubic feet of timber of several different species, among them big-leaf mahogany and Spanish cedar (Zon and Sparhawk 1923). In 1919, 504,000 board feet of big-leaf mahogany and 273,000 board feet of Spanish cedar were exported; corresponding figures for 1920 were 192,000 board feet of big-leaf mahogany and 231,000 board feet of Spanish cedar.

An incomplete chronology of big-leaf mahogany timber exports from 1934 through 2000 is shown in figure 5. Annual big-leaf mahogany lumber exports from 1934 through 1939 ranged between 5,060 and 210,960 board feet (see footnote 2). No export information was available for the war years between 1940 and 1946. In 1944, however, the big-leaf mahogany harvest was estimated at only 2,500 board feet (Garver 1947b). It is most likely that exports during this period were minimal.

From 1947 through 1955, annual exports ranged between 1.13 million to 3.67 million board feet. This surge was probably associated with postwar recovery, particularly in the United States. Other short-term estimates from this period are available from specific references. Between 1949 and 1951, 353,900 board feet of big-leaf mahogany and 6,500 board feet of Spanish cedar were harvested on Fort Clayton in the Canal Zone (Robinson and Graham, no date). Moreover, from 1944 through 1954, the average annual production of big-leaf mahogany was estimated at 3 million board feet, two-thirds of which was exported and the remainder used in Panama (Lamb 1953, 1954, 1959).

From 1956 through 1969, reported exports ranged between 1,100 and 435,930 board feet. Timber production in 1970-71 was reported at 1.40 million board feet (Doyle Rule) for big-leaf mahogany and 5.35 million board feet for Spanish cedar (Booth and Haugaard 1972, Browning 1973), a considerable portion of which must have been exported. The average annual production of big-leaf mahogany sawn wood between 1976 and 1979 was 16,380 board feet (Romero and others 1980). During the same period, the annual production of Spanish cedar averaged 34,855 board feet. From 1992 through 1997, the volume of big-leaf mahogany harvested through concessions averaged about 1120 m³ (Lao 1999). From 1980 on, the export record is incomplete; the volumes of big-leaf mahogany harvested, however, were most likely minimal.

In addition to big-leaf mahogany timber exports, log exports totaled 32.25 million kg between 1956 and 1970 (see footnote 2). The total exportation of Spanish cedar timber between 1952 and 1964 was 396,355 board feet; moreover, the export of Spanish cedar logs from 1956 through 1968 totaled 956 351 kg (see footnote 2).

In general, the chronology shows moderate timber exports before World War II, a halt during the war, a dramatic increase in the postwar years, and a gradual decline thereafter (fig. 5). During the latter period, however, dramatic changes in exports are apparent from year to year. Some of these may be related to expansion of the agrarian frontier or changes in government policy with regard to the timber resources. Colonization of the Darién began during

[2] Contraloría General de la República. 1974. Exportación de maderas por país de destino: años 1934-1950; exportación total registrada de maderas: años 1950 a 1973. Cuidad de Panamá, Panamá: Contraloría General de la República, Dirección de Estadística y Censo. 5 p. (unpublished archives).

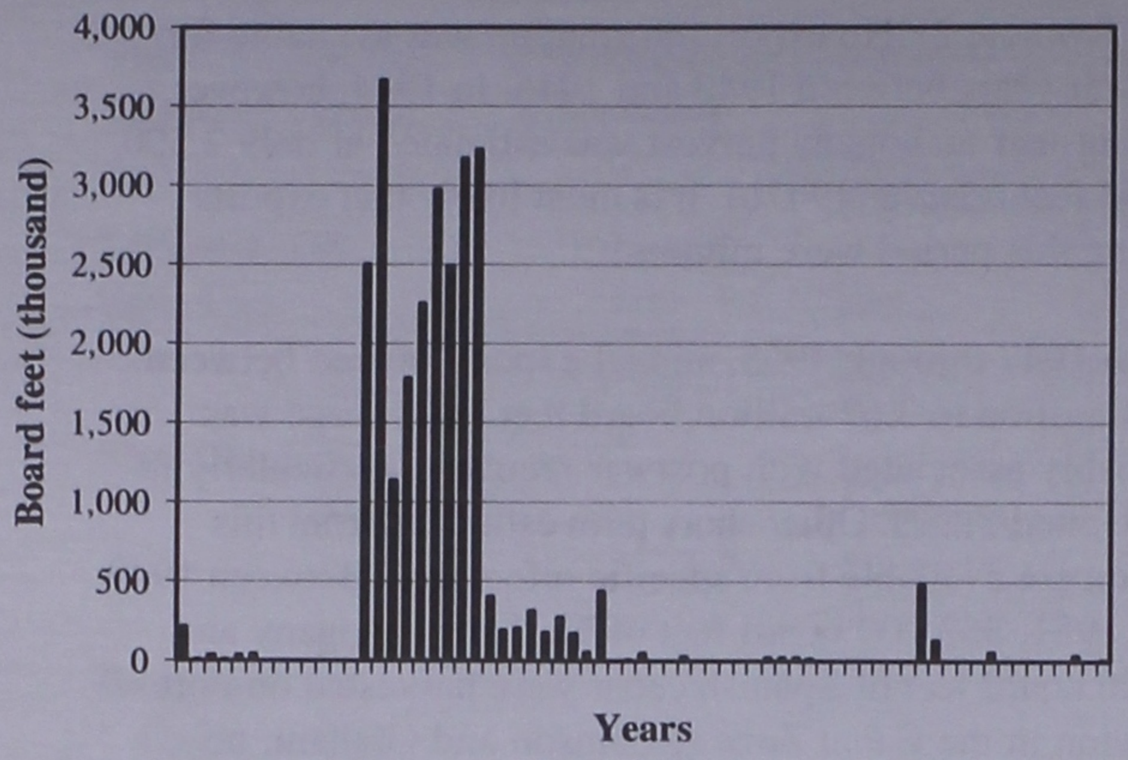

Figure 5—Chronology of timber exports for Panama, 1934-2000 (ANAM 1998-2001 (unpublished archives); Booth and Haugaard 1972; Browing 1973; Contraloría General de la República 1974 (unpublished archives); Delphin 1980; INRENARE 1988, 1989, 1992b; Romero and others 1980).

the 1970s, opening up previously untapped sources of big-leaf mahogany and Spanish cedar. The number of forest industries and their concessions increased significantly in the early 1980s, causing about 70 000 ha to be deforested annually (INRENARE 1992a). In 1983 and 1985, cutting was prohibited for several months. In 1986, INRENARE was created to manage renewable natural resources. Consequently, in 1987 cutting was prohibited for 5 years while the new government agency sought rational approaches to the use of forest resources.

Table 3—Regional distribution of big-leaf mahogany in Panama in 1992[a]

	Province areas	
Province	Forested	Mahogany habitat
	------ km^2 ------	
With mahogany		
Cocle[b]	470	822
Chiriqui[b]	1 178	1 300
Herrera[b]	100	1 500
Los Santos[b]	296	3 800
Veraguas[b]	2 980	7 295
Darién[c]	12 588	13 200
Panamá[c d]	5 388	9 890
Without mahogany		
Bocas del Toro[e]	5 935	—
Colón[e]	2 335	—
San Blase[e]	2 309	—
Total	33 579	37 807[f]

[a] Data based on inventories and interviews (Lao 1999).
[b] Mahogany present but uncommon in scattered areas. Harvest by individual tree.
[c] Mahogany present over wide areas but uncommon in occurrence. Harvest by concession.
[d] Mahogany not reported today west of the canal in Panamá Province.
[e] No naturally occurring big-leaf mahogany in province.
[f] Total area reported as mahogany habitat differs slightly from text citation of 40 240 km² (Calvo and others 2000).

Big-Leaf Mahogany Today

Big-leaf mahogany originally grew in forests that occupied about 37 807 km², or 49 percent of Panama (Lao 1999) (table 3). Another estimate is 40 240 km², or 53 percent of Panama (Calvo and others 2000). The actual area occupied today is only 10 500 km², representing a loss of about three-quarters of the original area. Only about one-fourth of the remaining area where big-leaf mahogany grows is in some type of protected status (Calvo and others 2000). Continued logging of natural stands will further reduce the numbers of big-leaf mahogany trees, fragment remaining populations, and may reduce genetic diversity.

The status of big-leaf mahogany today differs between western and eastern Panama (Lao 1999) (table 3). West of the canal (fig. 1), where concessions have not been granted since 1977, permits for exploitation are confined to remnant natural stands or planted areas. Harvesting is done on a tree-by-tree basis and numerous skilled craftsmen place a heavy demand on limited resources. Big-leaf mahogany is scarce, and its harvesting and processing are done locally. In contrast, east of the canal the forests are exploited by concessionaires to supply Panama's timber industries. Concessionaires must develop management plans for sustained production. These include impact statements, inventories with volume estimates, specification of the logging equipment to be used, and other requisites (Lao 1999). Either the government or indigenous peoples specify the terms of the agreements. Indigenous peoples control their resources and benefit from harvest on their own lands. They may sell trees directly to buyers or negotiate terms that allow the resale of timber. Lao (1999) listed numerous recent sightings of big-leaf mahogany trees scattered throughout the Pacific side of Panama.

Illegal logging is a common problem that continues today. The apparent reasons are the loggers' avoidance of paying the costs associated with felling permits and taxes, and the government's lack of control over management plans, border customs houses, and ports (Calvo and others 2000).

Silviculture and Management Activities

Tree Plantings, Plantations, and Genetics

Big-leaf mahogany may flower and fruit under favorable conditions as early as 12 years old (Lamb 1966). In Panama, abundant flowering occurs from January to March (Lao 1999). Seed quantity varies annually and in response to growing conditions. Seed production varies over a latitudinal gradient. In Mexico and Belize, it occurs during March and April; in Panama, it occurs during December (Navarro 1999).

During the 1920s, big-leaf mahogany and Spanish cedar were planted in the Canal Zone as shade trees in areas where they had grown in the wild (Standley 1928). Today, the streets of Panama City also contain many large big-leaf mahogany shade trees that were probably planted about the same time.

Before 1945, Panama had very little experience with the establishment of plantations (FAO and PNUMA 1981). Trees introduced at that time were for ornamental plantings. Big-leaf mahogany plantings made by United Fruit in Bocas del Toro during the 1940s are shown photographically in one report (Garver 1947b). In the late 1940s, teak (*Tectona grandis*) was also established on 1000 ha, of which about 300 ha still existed in 1980 (FAO y PNUMA 1981).

A survey of plantations in the Caribbean and Latin America in the late 1950s produced limited data on the growth of big-leaf mahogany and Spanish cedar in Panama (Wadsworth 1960) (table 4). At farms in tropical moist forest, dominant and codominant big-leaf mahogany trees averaged 1.4 m in height and 2.0 cm in d.b.h. over 11 years, and dominant and codominant Spanish cedar trees averaged 1.8 m in height and 2 cm in d.b.h. over 12 years.

During the early 1960s, some previously established plantations of big-leaf mahogany in Panama could not be located because they had been abandoned and their locations forgotten (Donaldson and others 1963). Shoot borer (*Hypsipyla grandella*) infestation was a problem as evidenced by plantings located in the Canal Zone. As a result of these experiences, further planting of big-leaf mahogany and Spanish cedar were not recommended.

In the mid-1960s, experimental trials were conducted with 58 native and exotic tree species as part of a cooperative

Table 4—Growth of big-leaf mahogany and Spanish cedar in Panamanian plantation trials

Species	Life zone	Area	Age	Survival	Height		
					Min.	Max.	Mean
		ha	*yr*	%	------- *m* -------		
Big-leaf mahogany	Tropical dry	0.20	5.2	65	0.5	7.5	6.0
	Tropical moist	0.20	3.6	90	0.8	5.5	3.8
	Tropical moist[a]	2.50	11.0	75	—	15.0	—
	Premontane rain[b]	0.10	2.7	56	1.0	4.0	2.3
Spanish cedar	Tropical dry	0.13	5.2	65	1.6	6.5	5.0
	Tropical moist	0.20	3.6	78	1.0	3.2	1.8
	Tropical moist[c]	4.00	12.0	50	—	21.0	—
	Premontane rain[b]	0.10	2.7	57	0.6	4.0	2.3

— = Data not available.

[a] Data for dominants and codominants on Higuito farm, 9 km north of Puerto Armuelles. Spacing, 4.5 x 9.2 m; average d.b.h., 22 cm.

[b] The total area for the premontane rain forest life zone plantings appears to be 0.85 ha for eight species, or an average of about 0.10 ha per species.

[c] Data for dominants and codominants on Majagua farm, 11 km north of Puerto Armuelles. Spacing, 4.5 x 9.2 m; average d.b.h., 24 cm.

Source: Howell (1972), Wadsworth (1960).

effort between the government of Panama and the United Nations Development Program (Howell 1972). Big-leaf mahogany and Spanish cedar were planted in tropical dry, tropical moist, and tropical premontane rain forest life zones. The total area for all plantings combined was slightly < 1 ha (table 4). The initial survival and mean height growth were satisfactory although all plantings were heavily attacked by the shoot borer. An evaluation of both species after 12.8 years showed that virtually all trees had died (Romero and others 1980). The exception was big-leaf mahogany on the tropical moist site, where 60 percent survived despite forking. Their average height and diameter were 10 m and 9 cm, respectively.

The International Institute of Tropical Forestry in Río Piedras, PR, initiated a study of 11 big-leaf mahogany provenances by collecting seeds in Mexico, Guatemala, Honduras, Nicaragua, and Panama during 1964 and 1965 (Geary and others 1973, Glogiewicz 1986). The Panamanian sites were located on Azuero Peninsula near the Güera Highlands (Altos de Güera, 7°35´ N. and 80°40´ W.), and in the Darién near the confluence of the Artigantí and Mortí Rivers (8°50´ N. and 78°00´ W.) (Glogiewicz 1986). Seedlings were planted at several sites in Puerto Rico and on the island of St. Croix, U.S. Virgin Islands. Subsequent measurements showed that height growth of the Panamanian trees was in the lower range of values among the different sources. The Panamanian trees also tended to fork lower and have thinner bark. Recent studies of big-leaf mahogany provenances among seven countries in Mexico and Central America showed that the height growth of Panamanian provenances was the lowest after 118 days (Navarro 1999). Diameter increment, however, was near the best.

In 1980, the requisites for collecting, storing, processing, and analyzing tree seeds from local sources were outlined for RENARE (Romero 1980). Today, the exploration of genetic resources and genetic variation of big-leaf mahogany in Panama is being coordinated through CATIE in Costa Rica (Patiño Valera 1997). The project is entitled "Determination of genetic variation in tropical arboreal species with economic and ecological importance in Central America and the Caribbean with implications for their conservation, use, and sustainable management."

As part of a systematic inventory of big-leaf mahogany genetic resources in Central America and Mexico, leaves, herbarium materials, and seeds were collected from 778 trees in 42 populations (Navarro 1999). Panama's samples came from 10 locations concentrated in the Azuero Peninsula, the Darién, and the Canal Area (fig. 3). The areas surveyed, between 10 and 500 m in elevation, yielded 41 leaf samples for DNA analysis, 39 herbarium samples, and 30 sites for seed collection. The research work was carried out through the collaboration of CATIE, ANCON, and INRENARE.

In 1990, Panama had about 10 000 ha of plantations, 70 percent of which were Caribbean pine (*Pinus caribaea*), 15 percent teak, with the remainder comprising numerous other species including big-leaf mahogany and Spanish cedar (INRENARE 1990). From 1992 through 1999, 38 217 ha were reforested on private and public lands throughout Panama (Herrera 2000), an amount that increased to 45 737 ha by 2001.[3] Teak is now the principal timber species being planted within the canal watershed (ACP 2002, Heckadon-Moreno and others 1999) and the rest of Panama (Herrera 2000). By 2001, teak accounted for 61 percent of the total area in plantations, Caribbean pine for 23.2 percent, African mahogany (*Khaya senegalensis*) for 3.3 percent, cedro espino (*Bombacopsis quinata*) for 2.8 percent, and acacia (*Acacia mangium*) for 2.7 percent. The remaining 11 species, accounting for only 7 percent of the total area planted, include big-leaf mahogany and Spanish cedar (Herrera 2000).

Recently, several groups have initiated reforestation programs in Panama. The ACP, through its soil conservation program, planted 70,500 trees near the Culebra Cut in the canal area between 1998 and 2001 (ACP 2002). Moreover, in 2001, the ACP, along with STRI, the Institute of Tropical Resources at Yale, and the Center for International Development at Harvard, initiated a native forest species project (ACP 2002). To date, 105 plots have been established to monitor the survival and growth of different tree species along with the growth of the forest understory. Apparently, big-leaf mahogany and Spanish cedar are being tested in small plantings mixed with other timber species.

ECOFOREST Panamá, a private Panamanian company dedicated to the planting of commercial timbers, initiated management on 2400 ha of Canal Area lands (lands that reverted to Panama) between 1999 and 2001 (ECOFOREST Panamá S.A., no date). Of the total area, 73 percent was planted in teak, 7 percent in native species, and 20 percent managed as protection forest. Of the portion in native species, 10 ha each were planted in big-leaf mahogany and Spanish cedar.[4] ARI's unpublished files also indicate that

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[3] ANAM. 1998-2001. Exportación de caoba (*Swietenia macrophylla*). Cuidad de Panamá, Panamá: ANAM 1 p. (unpublished archives)

[4] ARI. [N.d.]. Proyectos de reforestación. Cuidad de Panamá, Panamá: Administración General, Oficina de Gestión Ambiental y Comunitaria (unpublished archives).

5 ha of big-leaf mahogany were planted by the José Carriero Company.

In some areas, watershed protection and biological diversity may be among the major management objectives. In much of the canal watershed, for example, it would seem more appropriate and less costly to allow the regeneration of secondary forest than to establish plantations.

Forest Management and Research

Panama has no current management programs for the Meliaceae (Navarro 1999) and there is little evidence of management in the past. Historically, the forest concessions granted by the Panamanian government were not supervised; consequently, any possible benefits to be derived from good forest administration, management, and conservation, were sacrificed (Boyer and others 1980).

Numerous reports aimed at initiating or improving forest management, however, did appear over the years. In the late 1940s, a clear need was seen for forest inventories (Garver 1947a, 1947b). By the mid-1950s, it was recognized that at least 50 years would be required to produce commercial big-leaf mahogany timber from plantings (Lamb 1954). In the 1960s, protection of residual trees and regeneration were suggested as first steps in the controlled exploitation of Panama's forests (Donaldson and others 1963). The initial harvest should include all merchantable trees (and species) of satisfactory form and dimension, leaving promising residuals for future increment. In 1970, a dendrology manual was completed to help identify more than 1,000 Panamanian tree species, among them all of the commercially important timber species (Holdridge 1970). Moreover, the staff of the Wood Technology Laboratory and other cooperators collected more than 100 tree species in Panama, including the Darién, in order to positively identify them and determine their potential uses (Garibaldi 1982b, Slooten and others 1971). Wood characteristics and uses of 19 tree species native to Panama, including big-leaf mahogany and Spanish cedar, were described (Garibaldi 1982a). In 1982, a record of Panama's experience in timber exploitation, reforestation, silviculture, and use of forestry resources was compiled in a bibliography containing 200 references (Cagnatto and Montenegro 1982).

Regeneration of big-leaf mahogany in closed forests occurs mainly after major disturbances such as hurricanes or fires. After selective logging, however, it regenerates poorly and rarely survives because of insufficient light or competition from opportunistic species (Rodan and others 1992). Research in natural forest management in nearby Costa Rica could provide insight into the management of Panamanian forests with similar structure and composition. The work includes stand inventories, multipurpose management, controlled logging and damage assessment, economic evaluation of timber and nontimber products, and postlogging growth studies (Wendland and Bawa 1996).

Selective logging for prime timber species alone seriously hampers the management potential of forests containing big-leaf mahogany. The complete utilization of commercial species could open the forest enough to stimulate the regeneration and growth of big-leaf mahogany, especially if trees <75 cm, as specified by law (Lao 1999), were not cut.

A more positive approach would designate seed trees to foster regeneration along with silvicultural operations to stimulate growth. Benefits to society would be maximized if management objectives were expanded to include environmental services and nontimber products as well as the value-added processing of timber (Calvo and others 2000).

Three small agroforestry studies on big-leaf mahogany were carried out at the University of Panama during the mid-1980s. In the first study, corn (*Zea mays*) grown in association with big-leaf mahogany was judged to be a viable system of production (Bernal Moreno 1984). In the second, big-leaf mahogany interplanted with either marañon (*Anacardium occidentale*) or corn grew taller after 17 weeks than when planted alone (Rodriguez 1986). Fertilizer applications in the second study showed no significant results after 15 months. In the last study, fertilizer was applied to the same saplings after 3 years (Foster Juliance 1989). Seven months later, no significant differences were apparent although the saplings receiving the largest doses of fertilizer had grown the most.

In another study, big-leaf mahogany and Spanish cedar were planted in lines at 5- by 5-m spacing in secondary forest at Lajas in Chiriqui Province, about 60 km southeast of David (Vanegas Morales 1998). Lajas is situated in tropical dry forest at elevations between 25 and 40 m; rainfall averages 2500 mm per year. After 3 years, the big-leaf mahogany trees averaged 3.5 m in height, and the Spanish cedar 1.5 m.

In 1999, we saw isolated examples of line-planted big-leaf mahogany saplings on private properties in the Canal Area watershed. Since it is feasible today to economically extract a few trees of high commercial value, the future harvest of such plantings would likely be a profitable venture.

Protected Areas

Panama is the southernmost component of a proposed Meso-American corridor of protected areas extending from Mexico to Colombia (Carr and others 1994). The corridor was designed, on paper at least, to avert fragmentation of forested areas and to preserve biological diversity. Nearly 38 percent of Panama is proposed as part of the corridor.

The first of Panama's declared protected areas, the forest reserve La Yeguada, was set aside in 1960 (table 5). There are now 43 protected areas totaling about 1 900 000 ha, or nearly one-quarter of the country (Dirección Nacional de Areas Protegidas y Vida Silvestre 1998). Moreover, another 25 areas have been proposed. National parks comprise the largest management category with nearly 72 percent of the total protected area. Next in size is the protection forest (Palo Seco), followed by four wetlands, the wildland area (the Corregimiento de Narganá), and finally, five forest reserves. These management categories combined account for about 23 percent of the total protected area. The remaining seven management categories account for about 5 percent of the total protected area. The FAO's estimate for Panama's national network of parks and protected areas, possibly including areas not yet officially declared, is 2.2 million ha, or nearly 29 percent of the national territory (FAO 1998). Regardless of the exact size, if managed according to the stated objectives, these reserves could protect remnant populations and plantings of big-leaf mahogany and Spanish cedar. The reserves in the provinces of Herrera and Los Santos, as well as those located in the southern parts of Chiriqui, Cocle, Darién, Panama, and Veraguas (table 5) (figs. 1 and 3) are within the natural range of big-leaf mahogany.

In an attempt to predict which of 305 tree species would be threatened by logging in the Amazon, several ecological characteristics (capacity for long-range dispersal, abundance of saplings in forest regeneration, growth rate, capacity to sprout after cutting, capacity to withstand fire, geographic range, and abundance of mature trees) were assessed along with extraction pressure (Martini and others 1994). Using the rating system, big-leaf mahogany was classified as susceptible to population reductions after intensive logging. Spanish cedar, in contrast, was viewed as capable of withstanding logging pressures.

Although mature trees may be present, big-leaf mahogany does not regenerate well in closed forest (Gullison 1998). Major disturbances—for example, those associated with some types of past human activity, changes in water courses, fires, or hurricanes—are beneficial to its regeneration (Rodan and others 1992, Weaver and Sabido 1997). The difference between major natural disturbances and logging is that natural reproduction will support populations of big-leaf mahogany that vary in time and space. Logging, under the current socioeconomic and political environment, however, will not sustain populations. Pressures exist to cut all trees with economic value, including seed trees and those below the minimum diameter limit, with the proceeds being invested elsewhere (Gullison 1998).

It remains to be seen whether the protected areas in Panama and elsewhere in Central America are of sufficient size and stocking to protect big-leaf mahogany *in situ* (Newton and others 1993), and maintain genetic diversity (Navarro 1999). Protected areas themselves face numerous problems, among them boundary demarcation, land tenure conflicts, poor institutional coordination, and the politics of agricultural expansion (Calvo and others 2000). Threats include deforestation, illegal logging, and fires. The effective protection and management of existing reserves are dictated by available financial and human resources, which are scarce within the region. Unfortunately, as the big-leaf mahogany resource declines, pressures for illegal extraction from protected areas may be expected (Rodan and others 1992).

Conservation Efforts

Several approaches aimed at the conservation of big-leaf mahogany have been supported by different groups at the international level. The most extreme is a total ban on its importation (Gullison 1998). Others include the proposed listing of big-leaf mahogany on CITES, or its conservation through sustainable forestry management. The latter, focusing on the ecosystem, involves a certification process.

Panama's earliest concern with big-leaf conservation and logging practices dates back to 1941 when Law 35-A prohibited the harvest of big-leaf mahogany and Spanish cedar < 45 cm in diameter (Lao 1999). In 1962, Law 37 raised this minimum diameter for both species to 75 cm.

In the early 1980s, with the increase in the number of forest industries and their concessions (INRENARE 1992a), the Panamanian Government realized that timber supplies were limited and that reforestation efforts were inadequate. Past forestry incentives had considered the provision of seedlings, credit for plantations, tax breaks for reforested

Table 5—Panama's protected areas[a]

Management category	Area	Created	Province[b]
	ha	*yr*	
National parks (71.7%)			
Altos de Campana	4 816	1977	PA
Camino de Cruces	4 000	1992	PA
Cerro Hoya	32 557	1984	VE, LS
Chagres	129 000	1984	PA, CO
Coiba	270 125	1991	VE
Darién	579 000	1980	DA
General de División Omar Torrijos	25 275	1986	CC
Golfo de Chriqui	14 740	1994	CH
La Amistad	207 000	1986	BT, CH
Marino de Bastimentos	13 226	1988	BT
Portobelo	35 929	1976	CO
Sarigua	8 000	1984	HE
Soberanía	22 104	1980	PA, CO
Volcán Barú	14 000	1977	CH
Total national parks	1 359 772		
Forest reserves (4.7%)			
Canglón	31 650	1984	DA
La Fortuna	19 500	1976	CH
La Tronosa	20 579	1977	LS
La Yeguada	7 090	1960	VE
Montuoso	10 375	1978	HE
Total forest reserves	89 194		
Wildlife refuges (2.0%)			
Cenegón del Mangle	1 000	1980	HE
El Peñon de la Honda	2 200	1982	LS
El Peñon del Cedro de los Pozos	30	1991	HE
Isla Cañas	25 433	1993	LS
Isla Iguana	58	1981	LS
Islas Taboga and Urabá	258	1984	PA
La Barqueta Agrícola	5 935	1994	CH
Pablo Auturo Barrios	30	1992	LS
Playa de Boca Vieja	3 740	1994	CH
Total wildlife refuges	38 684		
Protection forest (6.6%)			
Palo Seco	125 000	1983	BT
Wetlands (6.3%)			
Golfo de Montijo	89 452	1990	VE
Lagunas del Volcán	143	1994	CH
Punta Patiño	13 805	1994	DA
San San Pond Sak	16 125	1994	BT
Total wetlands	119 525		

continued

Table 5—Panama's protected areas[a] (continued)

Management category	Area	Created	Province[b]
	ha	*yr*	
Natural monuments (0.3%)			
Barro Colorado	5 400	1994	PA
Los Pozos de Calobre	4	—	VE
Total natural monuments	5 404		
Natural park (0.01%)			
Metropolitano	265	1985	PA
Recreation areas (0.02%)			
El Salto de las Palmas	60	1994	VE
Lago Gatún	348	1985	CO
Total recreation areas	408		
Watershed protection areas (1.4%)			
Filo de Tallo	24 722	1997	DA
Tapagra	2 520	1993	PA
Total watershed areas	27 242		
Wildland area (5.3%)			
Corregimiento de Narganá	100 000	1994	KY
Biological corridor (1.6%)			
Bagre	31 275	1995	DA
Multiple use area (0.1%)			
Ciénega de las Macacas	2 000	1996	HE
All categories	1 898 769		

— = Information not available.

[a] Refer to figure 1 for location of provinces.

[b] BT = Bocas del Toro; CC = Coclé; CH = Chiriqui; CO = Colón; DA = Darién; HE = Herrera; KY = Kuna Yala (indigenous lands); LS = Los Santos; PA = Panamá; VE = Veraguas. Refer to figure 1 for location of provinces.

Source: Dirección Nacional de Areas Protegidas y Vida Silvestre (1998).

lands, and tax deductions on forestry investments but these were not widely used.[5] Among the difficulties evident were low stumpage prices, concessions of short duration, and plantation regulations that required authorization for cutting. Many suggestions were forwarded to overcome the lack of knowledge and to improve financial attractiveness and technical capability regarding forestry, such as

- Clarification of existing laws and drafting regulations
- Promulgation of a private-sector reforestation program
- Development of investment profiles for business
- Cost sharing in research, development, and extension
- Provision of plantation services
- Assistance to private reforestation companies
- Establishment of a private-public Panamanian reforestation authority

In 1983, and again in 1985, forest exploitation was temporarily suspended in Panama to establish norms for concessionaires. In 1986, INRENARE was created by Law 21 to formulate policy and manage renewable natural resources. The Institute's objectives were to define, plan, and coordinate policies and actions relating to the conservation and development of Panama's renewable resources (Dirección Nacionales de Areas Protegidas y Vida Silvestre 1998). In 1987, due to continued widespread deforestation, a resolution was passed to suspend all tree cutting throughout Panama for 5 years, during which time studies aimed at rational use of forest resources would be implemented (INRENARE 1992a). The ban, however, resulted in several purported negative impacts, among them the closing of forest industries, a loss of employment, and insufficient replacement of basic wood supplies through imports; moreover, the deforestation continued at the same rate as before the ban. It was suspended in 1990 (Feraud 1999).

In the early 1990s, Costa Rica and the United States proposed listing the genus *Swietenia* in appendix II of CITES (Rodan and others 1992). Appendix II listings require that trade volumes be documented and that trade be compatible with conserving the species at a level consistent with its role in the ecosystems where it occurs throughout its range. In 1992, Panama prohibited through Resolution J.D.-006-92 the export of any timber from the natural forest as roundwood. Moreover, it also prohibited the export of big-leaf mahogany, Spanish cedar, and other threatened species as sawnwood, but allowed their export as finished products.

Three principal laws passed during the 1990s currently guide forestry activities in Panama

- Law 24 of 1992 provided reforestation incentives for the private sector (Panamá 1992)
- Law 1 of 1994 established forestry legislation and introduced important concepts for sustainable forest management, such as community participation and sanctions for infractions (Panamá 1994)
- Law 41 of 1998 created ANAM (replacing INRENARE) as the Panamanian authority responsible for the environment (Panamá 1998). The law established the norms for the protection, conservation, and restoration of the environment to promote the sustainable use of natural resources. Moreover, it integrated social and economic objectives to achieve sustainable human development within the country

Today, there are 50 agencies in Panama involved with conservation; programs include environmental education, protection of conservation areas, reforestation, research, and technology transfer, among other activities (Harcourt and Sayer 1996). Moreover, Panama's national parks and equivalent reserves, encompassing almost 80 000 km^2, protect watersheds, lowland forests, and coastal and marine resources (Navarro and Fletcher 1988). Much of the activity is relatively recent in response to greater public awareness of the need to protect the watershed of the Panama Canal.

Future Alternatives: Conservation and Management

Big-leaf mahogany has been planted in a variety of urban and rural sites in Panama for more than 50 years (Calvo and others 2000, Sosa 1941). Among them are parks and farms, roadsides and fence rows, and school grounds, both within and outside of the tree's natural range. Big-leaf mahogany and Spanish cedar, because they are susceptible to the shoot borer (Newton and others 1993), were recommended for use in field border plantings but not in pure plantations (Howell 1972, Lao 1999). Other planting configurations were suggested, among them isolated individuals, small groups, line plantings, mixed plantings with other species, or combined with agricultural crops as in agroforestry. Well-spaced line plantings and taungya (agroforestry) plantings

[5] Laarman, Jan G. 1983. Government incentives to encourage reforestation in the private sector of Panama. Cuidad de Panamá, Panamá: National Administration for Renewable Natural Resources; United States Agency for International Development; U.S. Forest Service, Forestry Support Program. 51 p. (unpublished).

of both species have been successful (Evans 1984, Navarro 1999, Weaver 1987). The successful development of big-leaf mahogany plantations in Panama could contribute to meeting future demands for timber and reduce the pressure on natural forest (Evans 1984, Mayhew and Newton 1998).

Plantings for aesthetic purposes could also increase big-leaf mahogany in Panama. Big-leaf mahogany is recommended as an ornamental because of its straight trunk and dense crown (Schubert 1985). Continued planting of big-leaf mahogany in spacious urban parks, the Canal Area, and along rural roadsides is compatible with its attributes—its large size, spreading crown, and ample shade. Big-leaf mahogany should not, however, be planted in confined spaces within urban settings.

Panama's forest action plan (INRENARE 1990) pointed out numerous difficulties regarding the management of its forest resources, notably

- An inconsistent legal framework
- A preservationist attitude in forest management
- Insufficient funds for INRENARE to adequately handle forestry issues
- The lack of forest research
- The lack of attention to established plantations
- Undervaluing of forest resources

Panama's forest action plan also included general suggestions to improve the forestry situation under the headings of land use, forest industrial development, energy plantings, conservation of forest ecosystems, and strengthening institutions. There is ample opportunity for the establishment of big-leaf mahogany or Spanish cedar within several of the proposed action plan projects, such as reforestation, agroforestry, urban or highway landscaping, and the integrated management of the Panama Canal watershed. Moreover, management of timber concessions in eastern Panama using silvicultural guidelines for Central America's moist tropical forests (Louman and others 2001) could help regenerate big-leaf mahogany in postharvest secondary forests.

Recently, the status of big-leaf mahogany in Central America was assessed for the PROARCA/CAPAS project (Calvo and others 2000). Specific recommendations to improve the management of big-leaf mahogany in Panama were as follows (LAO 1999)

Short term

- Reduce the harvest of big-leaf mahogany by one-half until sustainable management plans for the species have been developed
- Approve the cutting of mature trees only after seed trees have been selected
- Identify and protect seed trees for a period defined by the forestry authority
- Establish a reforestation program for big-leaf mahogany.
- Request that the ANAM maintain electronic records of forestry information
- Control forestry activities nationally with trained personnel

Intermediate term

- Establish "project mahogany" in Panama to increase knowledge regarding the species, and to implement the best management alternatives
- Reinforce technically and financially the newly established national project on forest mapping and inventory as one way to learn more about big-leaf mahogany

Long term

- Formulate a program of genetic improvement that includes big-leaf mahogany

Certification of production in forests remains an alternative. As of 2000, certification with big-leaf mahogany had not yet been initiated in Panama (Calvo and others 2000). In 2001, however, ECOFOREST received certification for its management of plantations and protection forests (ECOFOREST Panamá S.A., no date).

Finally, it should be noted that one approach to help solve Panama's big-leaf mahogany problem has already been presented to its youngest generation. "Juanito y su mueble de caoba" ("Little Johnny and His Piece of Mahogany Furniture") is a Panamanian children's story about the fate of a mahogany tree that ends up as a chest of drawers in a little boy's room (Tejeira de Vanegas 1995). Little Johnny, after listening to his furniture tell him about its past life as a tree, says "I promise, my friend (the chest of drawers), that I will plant mahogany with my father and my teachers so that your lineage lives on." Indeed, in this case even the motive for the promise is appropriate, having been inspired as it was by the boy's fascination with an attractive forest product.

Acknowledgments

The FAO offices in Rome forwarded country reports. The library staffs at the ACP, ANAM, ANCON, ARI, the National Library, STRI, and the University of Panamá were helpful in locating information. Carlos Melgarejo of ANAM and Nelson E. Sandobal S. of the Contralería General de la República, Comercio Exterior, provided data on big-leaf mahogany exports. The maps were finalized by Maya Quiñones and Wilmari Díaz of the Landscape Ecology Program and GIS laboratory at the International Institute of Tropical Forestry, Río Piedras, PR. John Francis, Robert Hendricks, and Ariel Lugo of the U.S. Department of Agriculture Forest Service, and Shiela Ward of the University of Puerto Rico reviewed the manuscript and made helpful comments. This work was done in cooperation with the University of Puerto Rico, Río Piedras, and USAID, Panama.

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Appendix A

Glossary of acronyms used in text and literature citations with translated equivalents.

ACP: Autoridad del Canal de Panamá (Panama Canal Authority)

ANAM: Autoridad Nacional del Ambiente (National Environmental Authority)

ANCON: Asociación Nacional para la Conservación de la Naturaleza (National Association for the Conservation of Nature)

CATIE: Centro Agronómico Tropical de Investigación y Enseñanza (Tropical Agronomical Research and Higher Education Center)

CCT: Centro de Ciéncia Tropical (Tropical Science Center)

CITES: Convention on International Trade in Endangered Species (Convención Internacional para el Comercio de Especies Amenazadas de Fauna y Flora Silvestre)

FAO: Food and Agricultural Organization of the United Nations (Organización para la Agricultura y Alimentación de las Naciones Unidas)

INRENARE: Instituto Nacional de Recursos Naturales Renovables (National Institute of Renewable Natural Resources)

OAS: Organization of American States (OEA, Organización de Estados Americanos)

PAFT-PAN: Plan de Acción Forestal Tropical de Panamá (Panamanian Tropical Forest Action Plan)

PNUD: United Nations Development Programme (PNUD, Programa de las Naciones Unidas para el Desarrollo)

PNUMA: Programa de las Naciones Unidas para el Medio Ambiente (United Nations Environmental Programme)

PROARCA/CAPAS: Programa Ambiental Regional para Centroamérica (Central American Regional Environmental Program)

RENARE: Dirección Nacional de Recursos Naturales Renovables (National Administration for Renewable Natural Resources)

SAF: Servicio de Administración Forestal (Forest Service Administration)

SIG: Sistema de Información Geográfica (Geographic Information System)

STRI: Smithsonian Tropical Research Institute

UICN: Unión Internacional para la Conservación de la Naturaleza (International Union for the Conservation of Nature)

UNDP: United Nations Development Programme (Programa de las Naciones Unidas para el Desarrollo)

USAID: U.S. Agency for International Development (AID, Agencia de los Estados Unidos para el Desarrollo Internacional)

Appendix B

Chronology of events, mainly Panamanian, with implications for mahogany occurrence, exploitation, management, or trade.[1]

Date	Event
BC	
400	Indians use Panama as a gateway between Central and South America
AD	
1500	Panama is occupied by 60 Indian groups related to the Chibchas of Colombia, the most important being the Cuna, Choco, and Guaymi Indians
1501	Rodrigo de Bastides is the first European to land in Panama
1502	Columbus explores Panama's Caribbean Coast near mouth of Chagres River on his fourth voyage and establishes the settlement of Nombre de Dios
1513	Vasco Núñez de Balboa sights the Pacific Ocean from a mountain peak in the Darién
1513	Gonzalo Fernández de Oviedo (1478-1557) spends considerable time in Panama writing on history, native peoples, and regional products
1519	Panama City, the oldest surviving European settlement on the American mainland, founded on Pacific Coast by Pedro Arias Dávila, Balboa's successor
1519	Panama becomes transshipment route for Spanish colonists moving to west coasts of Central or South America
1523	Charles V of Spain directs Cortes to find a strait across the isthmus; in 1534, he directs Panama's local governor to look for a canal route
1550	Antonio Galvão, Portuguese navigator, states that it is possible to build canals through Mexico, Nicaragua, Panama, and the Darién
1572	Francis Drake destroys Nombre de Dios, later replaced by Portobelo
1670	Much readily accessible big-leaf mahogany is already harvested for the construction of mansions and interior decorating
1671	Henry Morgan captures and burns Panama City (probably much of the town built from big-leaf mahogany and Spanish cedar)
1730s	Panama declines as a transshipment center because of a treaty between Britain and Spain; by 1750, Panama becomes isolated as traders prefer route around Cape Horn to Peru
1821	Panama joins the Republic of Greater Colombia (Colombia and Venezuela) which declared its independence from Spain in 1819
1840	Panama maintains its independence from Colombia for 13 months under Tomás Herrera
1850	At least 53 revolutions, rebellions, insurrections, riots, and other outbreaks, from 1850 until Panama's declaration of independence, showed that Colombia was incapable of maintaining control over Panama
1855	Railroad across Panama is completed; big-leaf mahogany is used for railroad car interiors
1903	Panama declares its independence from Colombia and signs treaty with the United States for construction of the canal
1906	U.S. Congress finally adopts a high-level lake and lock plan for the Panama Canal based on the recommendation of its chief engineer, John Stevens
1908	Big-leaf mahogany is first exported to the United States
1914	Panama Canal is opened during August
1941	Law 35-A prohibits the cutting of big-leaf mahogany and Spanish cedar < 45 cm in diameter
1962	Law 37 prohibits the cutting of big-leaf mahogany and Spanish cedar < 75 cm in diameter
1966	Decree Law 39 establishes forestry legislation; repealed by Law No. 1 of 1994
1978	Panama ratifies CITES
1979	Panama gains sovereignty over canal
1982	Forest exploitation is temporarily suspended to establish norms for concessionaires
1985	Forest exploitation is again temporarily suspended because norms are not being followed
1986	Law No. 21 creates INRENARE as autonomous State entity to manage renewable natural resources
1987	Resolution No. 0013/87 suspends tree cutting nationally for 5 years
1990	Resolution J.D. No. 022-90 abolishes the 1987 tree-cutting suspension
1992	Panama (Resolution No. J.D.-006-92) prohibits the export of big-leaf mahogany, Spanish cedar, and other threatened timbers as roundwood; Law No. 24 establishes reforestation incentives in Panama
1994	Law No. 1 creates forestry legislation for Panama; Law No. 30 obligates environmental statements for projects, including forestry concessions and community forestry permits
1998	Law No. 41 creates ANAM, a national authority to replace INRENARE

[1] Compiled from the cited literature.

Weaver, Peter L.; Bauer, Gerald P. 2003. Big-leaf mahogany in Panama: historical perspective. Gen. Tech. Rep. IITF–24. San Juan, Puerto Rico: U.S. Department of Agriculture, Forest Service, International Institute of Tropical Forestry. 29 p.

The Isthmus of Panama, first used by Indians as a route between North and South America, was soon recognized by Europeans as an important crossroads linking two oceans and two continents. With Panama's colonization and settlement, the availability of big-leaf mahogany declined in readily accessible areas as early as 1670. The species remained common, however, in the interior through the beginning of the 20th century. Panama's low population density, concentrated along the canal and south of the topographic divide from Panama City west to the Costa Rican border, was a major factor that helped protect much of its forest land. No sawmills existed before work began on the canal; however, by 1913, 13 mills, mainly using big-leaf mahogany, had been established. Forests covered 86 percent of the country in 1900, declining to 70 percent in 1947, 58 percent in 1960, 53 percent in 1970, 47 percent in 1980, 40 percent in 1990, and 37 percent in 1998. In the early 1950s, the volume of big-leaf mahogany was estimated at 60 million board feet in the Darién and 75 million in the entire country. During the early 1990s, the forest industry supported 50 sawmills, 3 plywood factories, and 600 furniture shops. In 1992, as forest resources continued to decline, Panama prohibited the export of big-leaf mahogany, Spanish cedar, and select hardwoods as roundwood or sawnwood. Also during the 1990s, Panama passed laws providing incentives for reforestation, establishing forestry legislation, and creating ANAM, the national environmental authority. Today most of Panama's remaining undisturbed forests are concentrated along the Caribbean Coast and east of the canal. Big-leaf mahogany, once common, is now largely confined to scattered trees west of the canal, and to natural stands in the provinces of Panama and Darién east of the canal. The eastern forests are being harvested today by concessionaires with approved management plans.

Keywords: Big-leaf mahogany, conservation, history, Panama.